AIRMEC

RADIATION MONITOR TYPE 255

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AP.2466

Airmec Limited
High Wycombe
Buckinghamshire
England

High Wycombe 21201
Telex 83243

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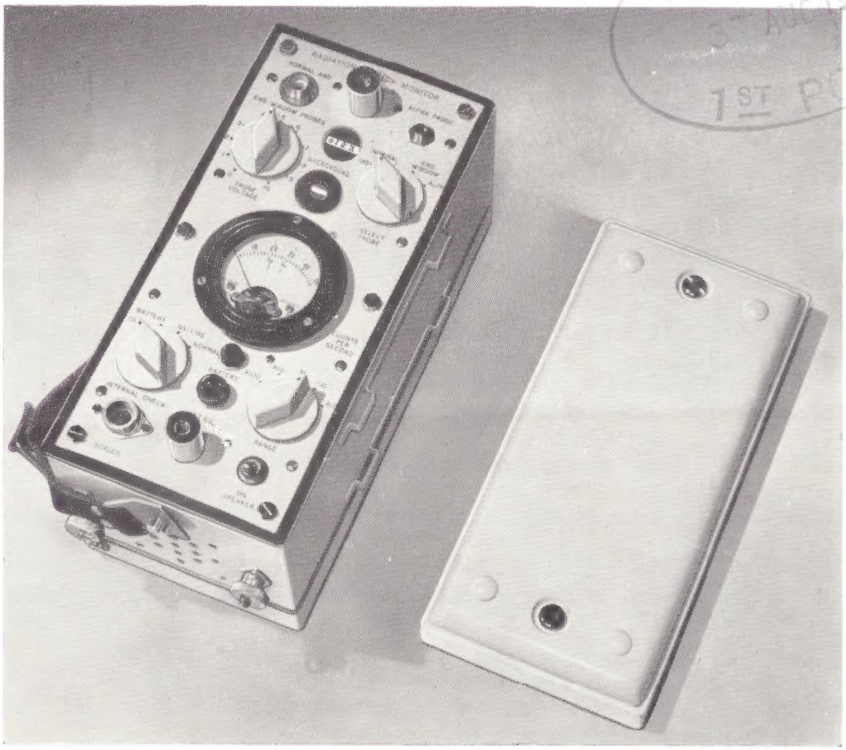


RADIATION MONITOR

TYPE 255

THIS RADIATION MONITOR is fully transistorised, battery operated and portable. It combines all the advantageous features of a field instrument with the accuracy of a laboratory ratemeter.

There are four probes, a sample holder and lead castle available for use with the instrument which also contains a built-in geiger tube for survey work. The equipment may therefore be used for a wide variety of purposes of which the following are examples :—

1. Checking the presence and amount of radio-active contamination of benches, walls, floors, clothes, equipment, glasswork, etc.

Being completely independent of mains supplies the monitor can be used instantly in passages, store rooms and parts of buildings remote from power plugs.

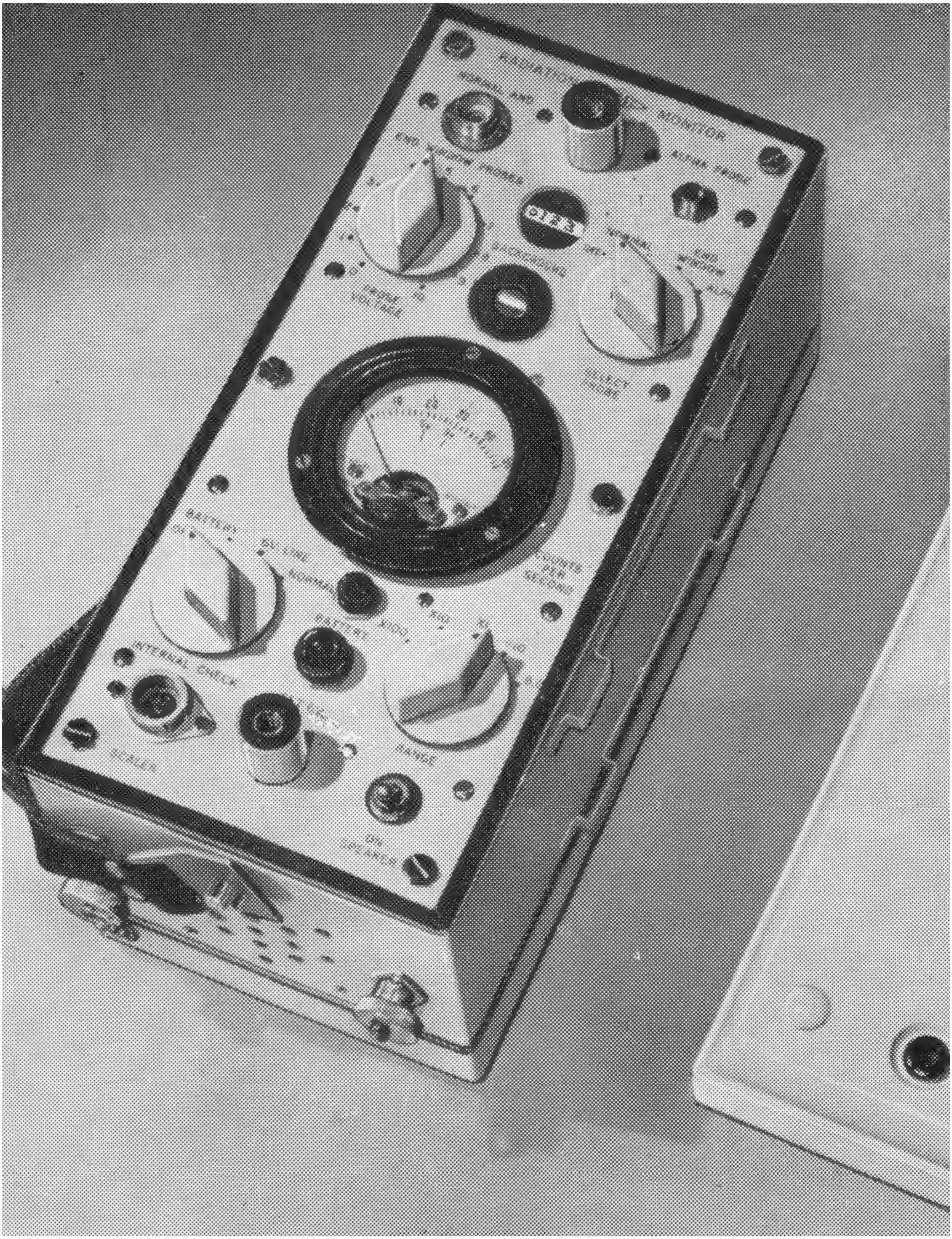
2. Checking atmospheric contamination or 'fall-out', including contamination of food, animals, crops, milk and water supplies as well as structures, buildings, etc.

Not only will the equipment indicate contamination of areas but it can also be used in the field to assess accurately the degree of contamination of samples of grain, food, liquids, etc.

3. Following the progress of radio-active tracer elements in river sediments, oil pipe lines, and applications encountered in food crop research, medical research, and various industrial processes.

4. Tracing the whereabouts of radio-active areas and making accurate assays of samples in geological surveys.

5. Tracing lost samples of radio-active materials both in buildings and out.


MONITOR
PROBE VOLTAGE
SELECT PROBE
BATTERY
INTERNAL CHECK
RANGE

GENERAL DESCRIPTION

The Radiation Monitor Type 255 consists of a Rate Meter Unit, four types of probe, and a Sample Holder, and a leather Probe carrying case. A Lead Castle is also available for use with the End Window and Liquid Sample Probes.

The Rate Meter Unit is fitted in a robust case with a removable cast aluminium lid and base. The lid is secured in position by two non-losable bolts the heads of which have coin slots for quick fixing and release. When removed the lid may be screwed onto the base of the unit to prevent loss and ensure complete portability.

The base consists of a similar casting to the lid and contains the batteries and a geiger tube for survey work. Changing batteries or the geiger tube does not therefore entail breaking the main seal of the unit. Rubber gaskets are employed between the body of the rate meter and the lid and base to ensure good sealing and weather proofing.

A webbing strap is attached for carrying purposes, and small straps are provided on one side of the case for securing a probe.

The four probes available are an Alpha Probe, a Beta Gamma Probe, an end Window Probe, and a Liquid Sample Probe. They are connected to the Rate Meter Unit by means of a 6 ft. connector which is suitable for use with any probe. The connector terminations are, however, arranged so that none of the low voltage probes can be accidentally connected to the high voltage Alpha Probe Socket on the front panel.

The Sample Holder enables Alpha, Beta and Gamma measurements to be made on samples of a known size and shape.

A separate carrying case is available for transporting the probes, sample holder, probe lead and sample trays when more than one probe needs to be carried. This is made of tropicalised leather and measures approximately 12″ x 11″ x 5″.

RATEMETER UNIT

Transistors are used throughout this unit and it is therefore extremely rugged and reliable. It includes a geiger tube in the base, and can be used without any external probes for detecting and monitoring gamma radiation.

The meter incorporated gives a clear and accurate indication of radiation intensity in four ranges 0-5000, 0-500, 0-50, and 0-5 counts per second. In addition an electromechanical counter on the front panel can be switched in for monitoring low rates of count with high accuracy. Audible indication is provided by the built-in loudspeaker which may be switched off when not required — and a socket for headphone connection.

Although, as will be seen from the specification given below, the stability of the unit is excellent with large changes of battery voltage, a control is provided on the front panel to compensate for the gradual fall in battery voltage so that the highest possible accuracy may always be obtained when required. The battery voltage is set up and can be monitored by the meter in one of the meter switch positions.

The batteries employed give a very long life with normal usage and are of a type available all over the world. Warning that the instrument is switched on is given not only by the audible background count and meter reading but by a neon indicator on the front panel. A warning plate on the top of the lid also reminds users to check that the instrument is switched off. A socket is provided for connection to a 12 volt accumulator if desired.

Figure 1. Radiation Monitor Type 255 base view showing batteries and G.M. tube.

ALPHA PROBE

A scintillation probe is used for the detection of Alpha particles. It employs a zinc sulphide scintillation screen the light from which is concentrated by a prismoid light guide on to a photo-multiplier tube. The light excluding screen is an aluminised terylene film having a density of 1 mg/cm^2.

The effective screen area of the probe is 5 sq. ins. and the sensitivity is such that it will detect Alpha particles having an energy of 4 meV or greater.

Although the terylene film covering the probe window is extremely tough and will stand up to all normal usage a sliding metal cover is provided in addition for protection purposes when the probe is not in use.

The removable handle can be fitted on the end of the probe in either of the two ways illustrated. For manual use either position may be found more convenient according to circumstances, but the position in Figure 3 is particularly useful for attaching the probe to a pole or other extension device when the user wishes to remain at a distance from the source of radio-activity.

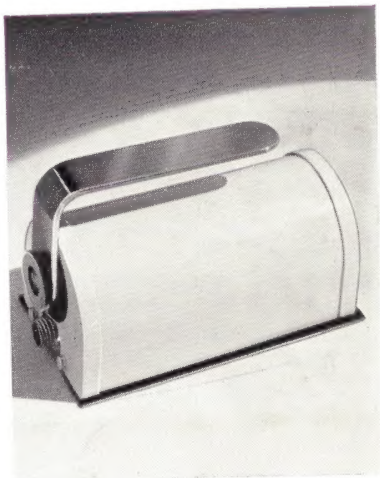


Figure 2. Alpha Probe Type 255

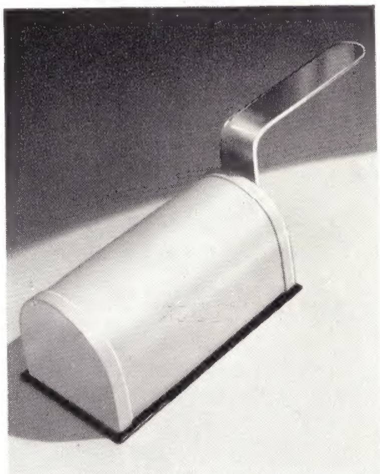


Figure 3. Alpha Probe Type 255 showing alternative method of fixing handle.

BETA-GAMMA PROBE

A low voltage thin walled ~~geiger~~ tube Type B12H is mounted in a cylindrical container for beta and gamma measurements. The wall density of the tube is 30-35 mg/cm^2, the sensitivity is 0.5 MeV beta and the dead time is of the order of 300 microseconds.

A shutter on the side of the probe enables beta radiations to be excluded and thus allows the probe to be used for monitoring gamma radiation only. The Geiger tube is coated with colloidal graphite to exclude light when the probe is operated with the shutter open.

The outer casing of the probe may be completely removed to allow the Geiger tube to be immersed in liquids when it is required to monitor them in bulk. For accurate measurements on small liquid samples a special liquid Sample Probe is available and this is described on the opposite page.

The removable handle which is identical to that employed on the Alpha Probe may also be mounted on this probe in either of the ways described in the previous section.

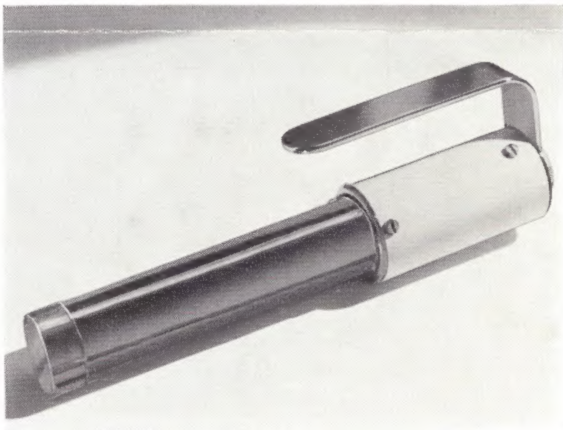


Figure 4. Beta Gamma Probe Type 255.

END WINDOW PROBE

This probe is suitable for the detection of high energy alpha and low energy beta radiation. It employs an end window geiger tube Type EW3H having a window density of 1.5 to 2.5 mg/cm^2, and a sensitivity of 0.1 MeV beta. The dead time of the tube is of the order of 700 microseconds.

A window of aluminised terylene film with a density of 1 mg/cm^2 is fitted for light exclusion purposes. This may be removed to obtain the full tube sensitivity when the probe is used with the Sample Holder or if light can be otherwise excluded.

The handle, which is identical to that employed on the Alpha and Beta Gamma Probes, can also be mounted in either of the positions described above.

LIQUID SAMPLE PROBE

The Liquid Sample Probe consists of a special geiger tube Type M2H designed to hold 5 millilitres of liquid with a fixed source geometry and mounted on a rigid base casting. The tube itself is sheathed in rubber and has a rubber top cap attached by a light chain.

The wall density of the tube is 15 mg/cm^2 the sensitivity is 0.5 MeV beta, and the dead time is of the order of 150 μs.

SAMPLE HOLDER

A sample holder has been specially designed for use with either the End Window Probe or the Alpha Probe to give a fixed source geometry. The drawer will take a dish of $1\frac{3}{4}''$ diameter and $\frac{1}{4}''$ deep (available from Airmec) or a standard A.E.R.E. 2″ sq. sample tray.

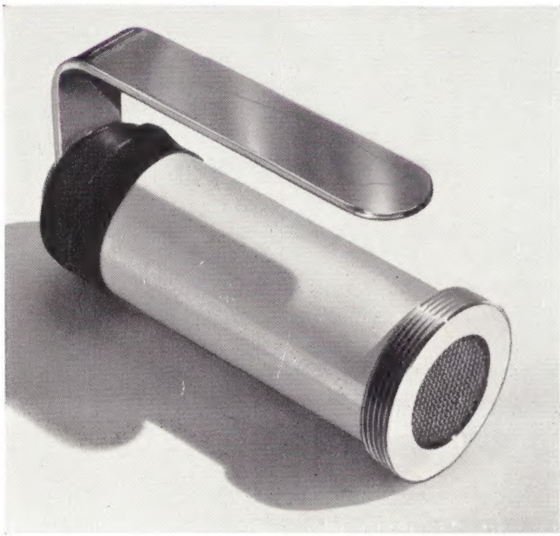


Figure 5. End Window Probe Type 255.

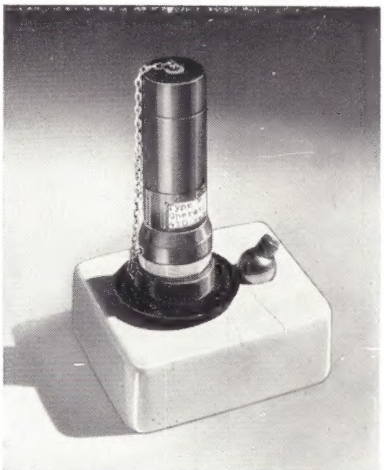


Figure 6: Liquid Sample Probe Type 255.

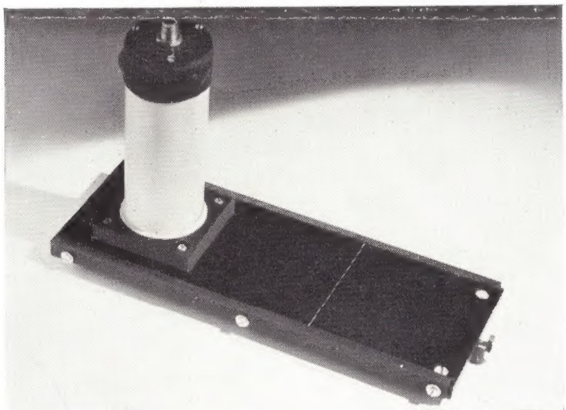


Fig. 7. Sample Holder Type 255 with End Window Probe

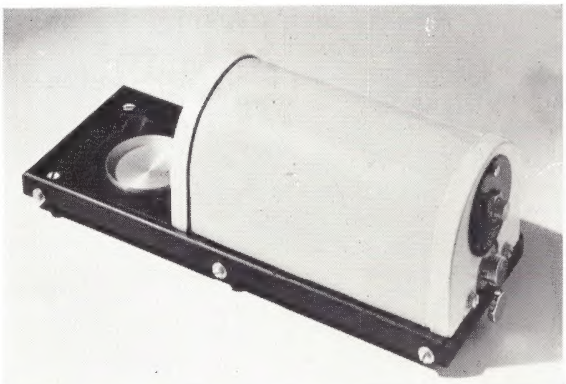


Figure 8. Sample Holder Type 255 with Alpha Probe.

Radiation Monitor
Type 255

SPECIFICATION

INDICATION :	1. A 2½″ meter on the front panel gives an indication of radiation intensity in counts per second. 2. A four figure electromagnetic counter on the front panel is used for background counting. 3. Audible indication is provided by a 2½″ loudspeaker mounted at the end of the unit. This facility is available on all ranges except the background range and may be switched off when not required. 4. Headphones or a hearing-aid earphone may be employed by connecting to a socket at the end of the unit.
COUNTING RANGES :	The main control selects one of the following meter ranges :— 0 – 5000 counts per second (X100 range) 0 – 500 „ „ „ (X10 „) 0 – 50 „ „ „ (X1 „) 0 – 5 „ „ „ (X0.1 „)
BACKGROUND RANGE :	A fifth position on the main control selects the electromagnetic counter for background counting. The maximum counting range for regular pulses is 25 per second, and for random inputs the resolution time is 20 milliseconds. When not in use the counter is completely out of circuit to avoid a steady drain on the batteries.
ACCURACY :	The accuracy of measurement for a regular pulse input is better than ± 2.5% of F.S.D. on the X100, X10, and X1 ranges, and better than ± 3% F.S.D. on the X0.1 range.
DEAD TIME :	The circuit dead times on the counting ranges are :— X100 range 20 microseconds X10 „ 200 „ X1 „ 2 milliseconds XO.1 „ 20 „
STABILITY :	A preset control on the front panel marked ' SET 6V ' enables compensation to be obtained for a fall in battery voltage. The electromechanical counter is unaffected by a fall in battery voltage of 25% (12 - 9 volts).
TEMPERATURE RANGE :	The equipment operates satisfactorily over the temperature range 0 - 40°C, the accuracies quoted being those at 20°C and below. At the limit of 40°C no error is increased by more than a factor of 2.
OUTPUT :	A negative pulse of not less than 1 volt amplitude and of constant level is available at a single way plug on the front panel for operating an external scaling unit.
INTERNAL GEIGER TUBE :	A robust low voltage geiger tube for gamma radiation is mounted inside the Ratemeter Unit and can be selected by means of a panel switch. It will detect gamma radiation down to 0.1 MeV.
PROBE VOLTAGES :	The voltage ranges available for the probes are 300–500 volts, 500-700 volts, and 900–1100 volts. Each range is variable in steps of about 30 volts. The voltages are stabilised and do not fall by more than 1.5% for a fall in battery voltage of 25% (12 - 9 volts).

SPECIFICATION (continued)

PROBES :
The following probes are available for use with the Monitor :—
1. Beta/Gamma Probe — for beta and gamma measurements.
2. End Window Probe — for detection of high energy alpha and low energy beta radiation.
3. Alpha Probe — for detection of alpha particles.
4. Liquid Sample Probe — for beta and gamma measurements on liquids.

CONNECTOR :
A 6 ft. connector is provided and is suitable for use with any of the probes. The terminations are arranged so that none of the low voltage probes can accidentally be plugged into the high voltage Alpha Probe socket on the front panel.

SAMPLE HOLDER :
This is designed for use with either the End Window Probe or the Alpha Scintillation Probe to give a fixed source geometry. The drawer will take x $1\frac{3}{4}''$ diameter x $\frac{1}{4}''$ deep dish or a standard A.E.R.E. 2″ square sample tray.

BATTERIES :
The instrument is powered by eight 1.5 volt leak-proof dry cells type U2 arranged to form a 12 volt battery.
When used for 4 hours per day, the battery life, without the loudspeaker in use, is at least 120 hours. The life with the electromagnetic counter or loudspeaker in use at 5 counts per second is more than 60 hours.
Alternatively the instrument may be operated from a 12 volt accumulator or a 12 volt power pack.

WARNING :
A neon indicator on the front panel provides a warning that the instrument is switched on, and a warning plate on the top of the lid reminds users to check that the instrument is switched off.

DIMENSIONS :
Ratemeter Unit : 12″ long x $5\frac{1}{2}''$ wide x $8\frac{1}{2}''$ deep (30.5 x 14 x 21.6 cms.).
Beta/Gamma Probe : 9″ long x 2″ in diameter (22.9 x 5 cms.).
End Window Probe : $5\frac{1}{2}''$ long x 2″ in diameter (14 x 5 cms.).
Alpha Probe : $6\frac{1}{4}''$ long x $3\frac{1}{4}''$ wide x 3″ deep (15.9 x 8.2 x 7.6 cms.)
Liquid Sample Probe : $3\frac{3}{8}''$ long x $3\frac{3}{8}''$ wide x $2\frac{1}{8}''$ deep (8.6 x 8.6 x 5.4 cms.).
(Geiger height 4″ — 10.2 cms.).
Sample Holder : $9\frac{3}{4}''$ long x $3\frac{3}{4}''$ wide x $1\frac{1}{8}''$ deep (24.8 x 9.5 x 2.8 cms.).

FINISH :
All units with the exception of the Sample Holder are finished in stove enamel medical cream.
The Sample Holder is anodised matt black.

WEIGHT :
Ratemeter Unit : 16 lbs. (7.25 kgs.) (complete with batteries).
Beta/Gamma Probe : 14 ozs. (398 gms.) less handle.
End Window Probe : 7 ozs. (199 gms.) less handle.
Alpha Probe : 1 lb. 1 oz. (7.53 gms.) less handle.
Liquid Sample Probe : 12 ozs. (341 gms.).
Sample Holder : 1 lb. 7 ozs. (7.45 kgs.).
Handle : 3 ozs. (85 gms.).
Connector : 4 ozs. (114 gms.).

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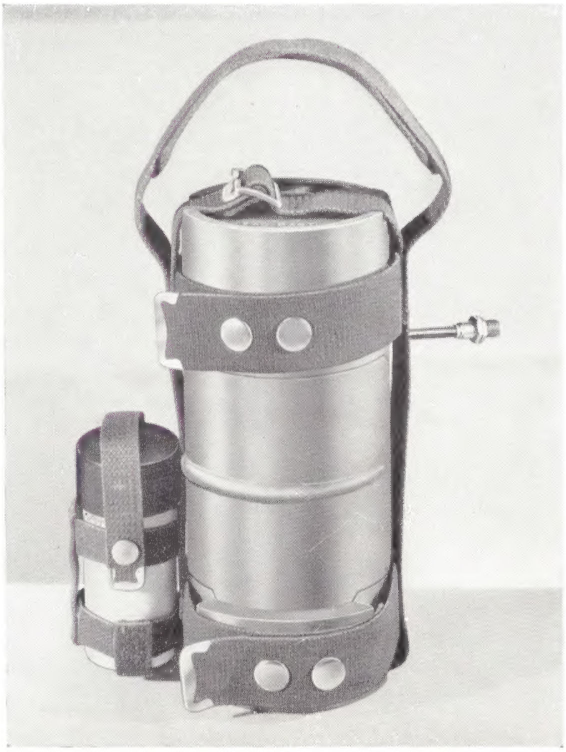


LEAD CASTLE

TYPE 295

THE Lead Castle Type 295 is designed primarily for use with the Airmec Radiation Monitor Type 255 to minimise the effects of all other sources of radiation when testing radio-active materials.

Either solid or liquid samples may be tested by the use of the appropriate Geiger tube type EW3H or M2H respectively. The tube type M2H holds 3.5 millilitres of liquid, and the drawer provided for checking solid samples accommodates the standard A.E.R.E. 2″ square tray, 2″ or 1¾″ planchets, or 1¾″ diameter by ¼″ deep dishes.

Despite the light weight of 45 lbs. which enables the assembly to be carried by one man, the wall thickness shielding the sensitive volume is 1¼″ of lead.

A special feature is the ease with which a conversion may be made from testing solid samples to liquid samples and vice versa, merely by inverting the method of assembly and fitting the appropriate type of Geiger tube. Stowage for the unused tube is provided on the carrying strap.

Lead Castle

Type 295

SPECIFICATION

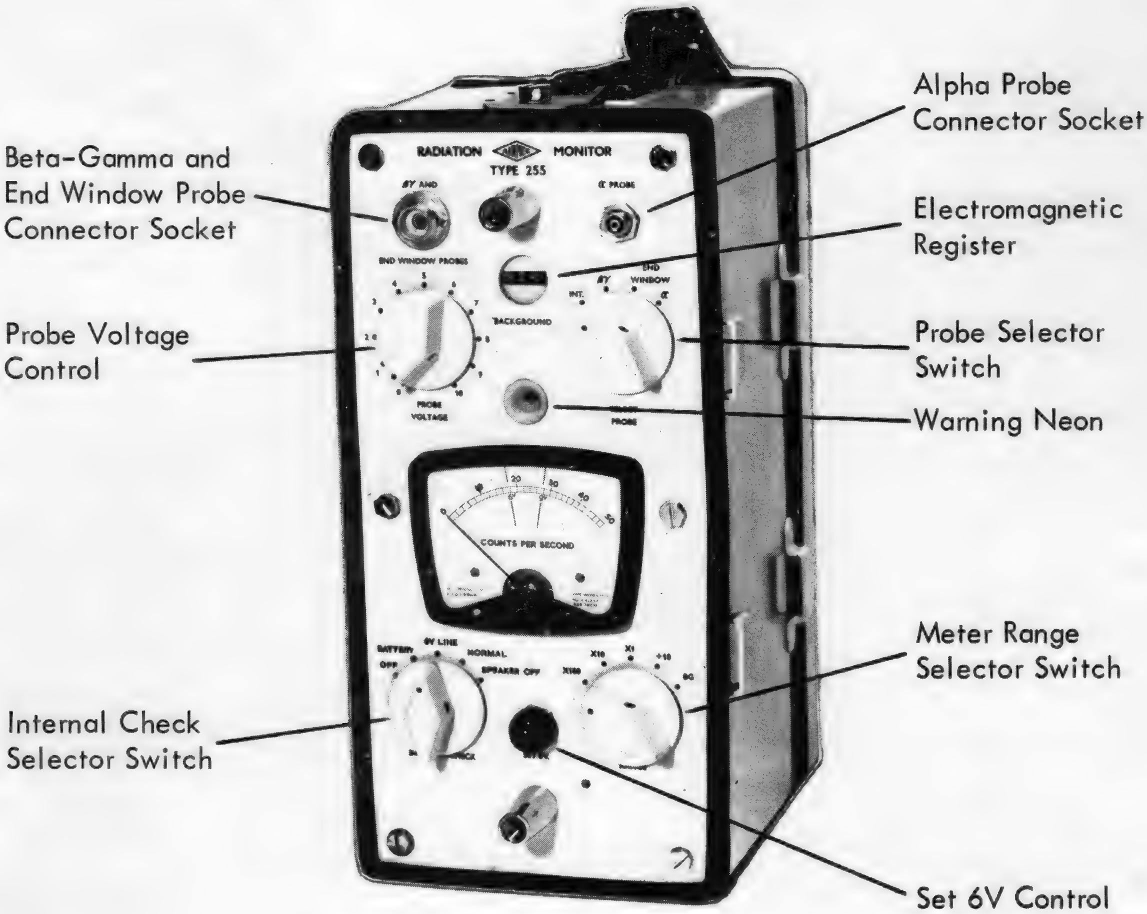
Reduction in Radiation	:	The castle provides a reduction of X10 in gamma radiation from mixed fusion products.
Shielding	:	$1\frac{1}{4}''$ thickness of lead (4% Antimonial to A.E.R.E. Specification 420).
Solid Samples	:	A shielded drawer assembly takes the standard A.E.R.E. 2″ square tray, 2″ or $1\frac{3}{4}''$ planchets, or a $1\frac{3}{4}''$ diameter by $\frac{1}{4}''$ deep dish.
Liquid Samples	:	The liquid jacket of the Geiger tube type M2H has a capacity of approximately 3.5 millilitres.
Geiger tubes	:	20th Century EW3H for end window tests on solid samples. 20th Century M2H for liquid sample tests.
Construction	:	Three interlocking lead pieces of easily manageable weight. Conversion from liquid to solid samples and vice versa is by inversion of the method of assembly and fitting of the appropriate tube into the composite holder.
Dimensions	:	The outside dimensions are $4.\frac{13}{16}''$ diameter x $9\frac{5}{8}''$ high (122 x 245 mm.). The internal cavity is $1\frac{3}{4}''$ diameter x $6\frac{1}{2}''$ high.
Weight	:	Approximately 45 lbs. (21 kg.).
Finish	:	Silicone wax direct on the lead.
Carrying Strap	:	A webbing strap is provided which enables the castle to be carried by one man.
Tube Stowage	:	A tubular container is attached to the carrying strap for stowage of the Geiger tube not in use.

These specifications are representative of average instruments and we reserve the right to effect modifications.

A I R M E C   L I M I T E D

HIGH WYCOMBE, BUCKINGHAMSHIRE, ENGLAND.

Telephone: High Wycombe 2501 (7 lines)   *Cables:* Airmec, High Wycombe



RADIATION MONITOR TYPE 255

Location of Front Panel Controls

CONTENTS

1. INTRODUCTION

The Radiation Monitor Type 255 is a portable equipment for detecting alpha, beta, and gamma radiation. It indicates radiation intensity in terms of "counts per second" on a meter with four switched ranges, and for aural monitoring a built-in loudspeaker and a headphone jack are provided; in addition, there is a four-digit electromagnetic register which can be switched into circuit for integration or for background counting. The instrument is fully transistorised and is powered by eight U2-type dry batteries with a life in use of at least 120 hours at 4 hours per day.

The complete equipment, illustrated opposite, consists of a Ratemeter and four types of probe. The Ratemeter is contained in a strong sealed case fitted with a carrying strap and has a built-in Geiger-Muller tube for detecting gamma radiation. A fitted leather case is available for carrying the probes and a lead castle can be supplied for reducing the effect of background radiation when making tests on small samples.

2. INITIAL ADJUSTMENTS

The Ratemeter as supplied is fitted with fresh batteries, and both top and bottom lids are in position.

IF IT IS TO BE STORED FOR ANY LENGTH OF TIME BEFORE USE, TAKE THE BATTERIES OUT.

To use the Ratemeter, take the top lid off by undoing the captive hold-down screws and stow it by clamping it over the lower lid with the same screws.

Check battery voltage by setting the Internal Check switch to BATTERY and the Range switch to x 10 or x 100. The meter needle should read above the red 9V mark on the scale.

Check the internal 6V line by setting the Internal Check switch to 6V LINE. The meter should read exactly 6V. If it does not, take the black cover off the Set 6V control and adjust it with a screwdriver to bring the needle exactly over the red 6V mark on the scale.

Turn the Internal Check switch to NORMAL and the Monitor to ready for use. No warm-up time is necessary since stable operating conditions are reached within 10 seconds of switching on.

3. OPERATION

3.1. General

The instrument may be used either by itself, using the built-in Geiger tube, or with one of the probes connected. The probe cable is fitted with different sizes of plug at opposite ends, as a precaution to ensure that the correct supply socket is used for the different types of probe. The beta-gamma probe has a rotatable shutter for stopping beta particles and enabling gamma radiation only to be measured.

Control settings for using each of the probes are summarised in Table 1.

The electromagnetic register on the Ratemeter Unit is intended for use at low counting rates, such as measuring the radioactive background or taking measurements on low-activity sources. It is brought into use by setting the Range Selector to BG and the Internal Check switch to NORMAL; both the meter and the loudspeaker are then cut out of circuit.

TABLE 1. MEASUREMENT PROCEDURES

Application	Control Settings			
	Internal Check	Probe Selector	Range Selector	Probe Voltage
Ratemeter Only, with built-in Geiger tube	Normal	Int.	x1	0, then advance until background is just being counted as shown by intermittent clicks in loudspeaker. Then advance one more notch (about 30V) to operate Geiger tube on its plateau.
Beta-Gamma Probe	Normal	$\beta\gamma$	x1	0, then advance until background is just being counted as shown by intermittent clicks in loudspeaker. Then advance one more notch (about 30V) to operate probe on its plateau.
Alpha Probe	Normal	a	x1	0, then advance until background is being counted at a rate of about one click per second in the loudspeaker. Then reduce by one notch (about 30V) to bring operating point away from noise region.
End Window Probe	Normal	End Window	x1	As for Beta-Gamma Probe
Liquid Sample Probe	Normal	$\beta\gamma$	x1	As for Beta-Gamma Probe

3.2. Ratemeter with built-in Geiger tube

Set the controls as given in Table 1.

For measuring gamma radiation it is not necessary to remove the lower lid since it is of aluminium alloy and is virtually transparent to this type of radiation.

The instrument may be carried by its shoulder strap or placed on a bench for the general monitoring of the radioactive background. When used with a radioactive source, if the distance between the geiger tube and the source is required to be known, the longitudinal centre line of the instrument may be taken as the centre line of the geiger tube. The height of the geiger tube above the bench is approximately 2.1/4" or 1.1/4" depending on whether both or only one of the lids is fitted on the underside of the instrument.

The reading obtained on the meter will depend on the strength of the source and its distance from the geiger tube and the Range switch should be set accordingly.

Any further check of the 6V line should be made with the signal temporarily removed in order to obtain an accurate reading. This can be done either by setting the probe selector switch to some other position or reducing the probe voltage.

3.3. Beta-Gamma Probe

Connect the probe to the socket on the Ratemeter Unit with the special cable supplied and set the controls as given in Table 1.

For measuring beta radiation, open the probe shutter by turning the end cap, and aim the aperture at the source of radiation.

For measuring gamma radiation the shutter may be in either position unless it is desired to exclude beta particles, when it should be closed.

To use the probe for dipping, remove the shutter assembly by unscrewing the three retaining screws farthest from the connector. The probe can then be immersed up to the base of the geiger tube,

3.4. Alpha Probe

Connect the probe to the socket on the Ratemeter Unit with the special cable supplied and set the controls as given in Table 1.

The probe may be either hand-held or used on the sample holder. The handle may be fitted in one of two positions (over the top of the probe, or projecting rearwards from it) by undoing the knurled retaining nut. The second position enables the probe to be easily fastened to a pole, so that the operator can keep at a safe distance while monitoring a highly active source.

To use the probe with the sample holder, remove the End Window adaptor from the holder before sliding the probe onto it.

3.5. End Window Probe

Connect the probe to the Ratemeter Unit with the special cable supplied and set the controls as given in Table 1.

The probe may be either hand-held or used on the sample holder. For hand-held use, aim the wire-mesh end at the source of radiation; the handle can be fitted in one of two positions, as for the beta-gamma probe, by undoing the knurled retaining nut.

To use the probe with the sample holder, screw it into the End Window adaptor and then slide it onto the holder.

The thin end window of the tube is protected by a sheet of metallised terylene film and a wire mesh. For measurements requiring maximum sensitivity, the terylene film and wire mesh can be removed to expose the thin mica window of the geiger tube. To remove these, take off the neoprene sleeve and the three 4BA retaining screws, then slide the base assembly and geiger tube out and remove the terylene film and wire mesh. Replace the base assembly and geiger tube and re-assemble the probe. When this is done, take care to avoid damaging the mica window and also to exclude light, for this will falsify the measurement and is liable to damage the tube.

3.6. Liquid Sample Probe

Connect the probe to the Ratemeter with the special cable supplied and set the controls as given in Table 1.

Place the probe on a flat surface, take off the neoprene cap at the top, and pour in the sample of liquid.

After use, pour out the sample and then wash out thoroughly. The geiger tube can be taken out and washed separately.

3.7. Corrections

In order to obtain the greatest accuracy of measurement, it is necessary to apply corrections to the observed reading to allow for dead time, background radiation, and statistical factors.

3.7.1. Dead time

Dead times of the probes are approximately:-

Built-in Geiger in Ratemeter	300μS
Beta-Gamma probe	300μS
Alpha probe	10μS
End Window probe	700μS
Liquid Sample probe	150μS

These dead times will vary with temperature and counting rate; to compensate for this variation, fixed and accurately calibrated dead times are introduced into the Ratemeter circuit to enable the true count to be determined.

These circuit dead times are:-

20μS on the x100 range
200μS on the x10 range
2mS on the x 1 range
20mS on the ÷10 range

By selecting the range to give a longer circuit dead time than the probe in use, any variation in probe dead time is allowed for and the true count per second can be determined from the expression:-

$$n = \frac{n_o}{1 - n_o t}$$

Where n is the true count per second
n_o is the observed count per second
t is the circuit dead time in seconds

3.7.2. Background

The count indicated by the monitor, with a radioactive source present, is due to the source plus the natural radioactive background. To correct for back-

ground, first measure the background level with no radioactive source present, and apply dead time correction to the background count. Then take a measurement with the radioactive source present, and apply dead time correction to this reading also. Finally subtract the corrected background reading from the corrected total reading, to obtain a true reading of source radiation only.

3.7.3. Statistical

Radioactivity is random in nature, and therefore the intensity of radiation from a source varies from instant to instant in a random manner. As a result of this, it is necessary to average out the instantaneous counting rates over a comparatively long time in order to get a satisfactorily accurate measurement.

To arrive at a practical method of averaging, it is necessary first to consider how the Type 255 Monitor works. Basically, an electronic circuit produces one electrical pulse for each atomic disintegration detected. When the controls are set so that the meter is in use, additional circuits are brought into operation which automatically and continuously average out the instantaneous pulse rates from this circuit. If the meter range switch is set to x1 or ÷ 10, averaging occurs over a period of approximately 6 seconds; if the switch is set to x10 or x100, the period is approximately 0.6 seconds. When the controls are set to drive the electromagnetic register or an external scaler, the integrating circuits are disconnected and no averaging occurs.

The following methods of averaging have been found to give satisfactorily accurate results in practice.

(a) Using Meter. Take a measurement over a period of approximately one minute. Estimate by eye the mid-point of any fluctuations of the meter needle and take this as the reading.

(b) Using Register or External Scaler. Take a count over at least two minutes, or longer if the source is only feebly radioactive, before dividing by total elapsed time to get the average count per second.

3.8. Conversion to dosage

For some purposes it is necessary to convert the counting rate into terms of dosage, measured in millirads/hour.

For gamma radiation the conversion factor depends on the energy of the radiation and the geiger tube used. The approximate conversion factors for two of the most common gamma emitters, for a radiation field of 2.5 millirads/hour, are:-

Radium 226 and Cobalt 60 (Energy 1.25MeV)	15,000 counts/minute (250 counts/second)

The relationship is linear for counting rates up to about 30,000 counts/minute (500 counts/second) when using either the Internal Geiger Tube Type G10H or the Beta Gamma Geiger Tube Type B12H.

3.9. Calibration Service

Airmec operate a calibration service for their radiation monitors. Details of time and charges are available from the Service Department and the monitors can be calibrated for the following sources:-

Source	Range (millirads/hr)
Cobalt - 60	0.3 - 30
Strontium - 90	0.75 - 20
Caesium - 137	0.3 - 30
Thallium - 204	0.75 - 20

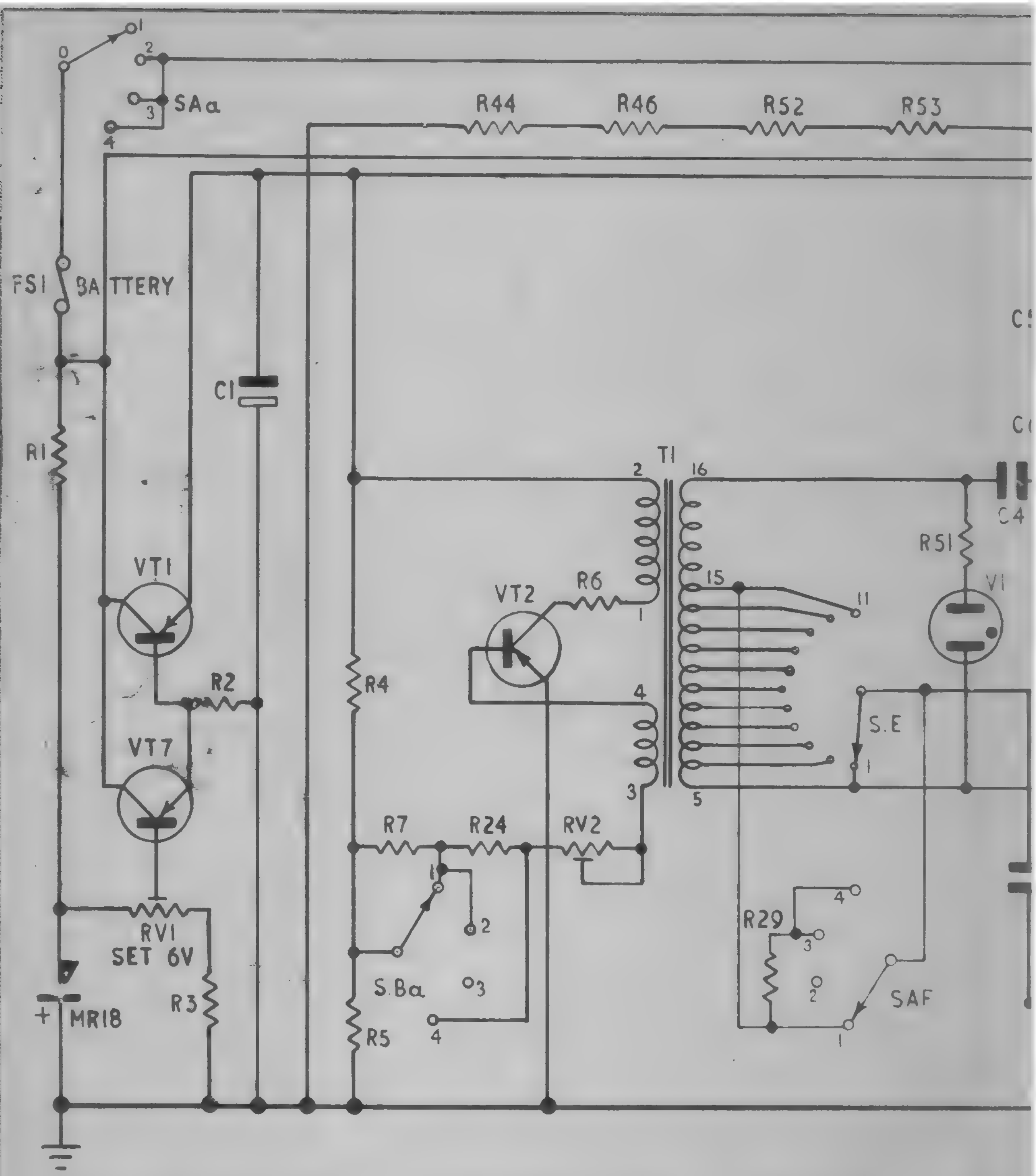
3.10. External scaler

A signal is provided from the OUTPUT socket at the end of the unit for operating an external scaling unit. This is advantageous when a permanent record is required of events occurring at a higher average speed or requiring a shorter resolution time than is provided by the background register.

The output is in the form of a negative rectangular pulse of not less than 1V amplitude. It has a duration approximately equal to the dead time of the trigger circuit, determined by the setting of the Range switch. On the BG range the pulse duration is the same as on the ÷10 range.

Connect the output to the scaler with a screened connector not more than 6 feet long. Use the pins on the output socket marked SCALER and E (earth). The earth return must be completed.

All the facilities remain operative with an external scaling unit connected, provided that the input impedance of the scaler is not less than 1,000Ω.



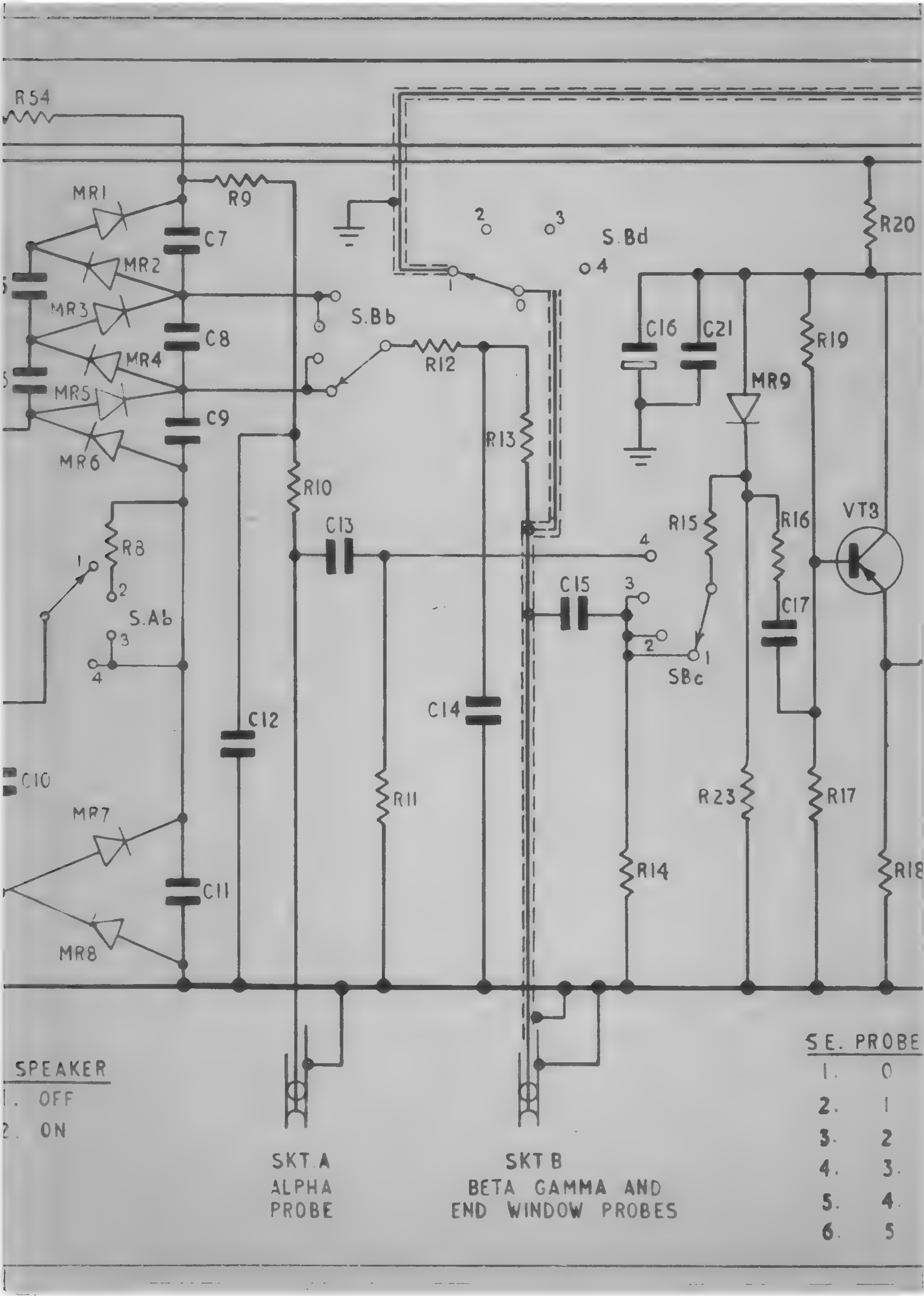
S.A INTERNAL CHECK
1. OFF
2. BATTERY
3. 6V LINE
4. NORMAL

S.B SELECT PROBE
1. INTERNAL
2. BETA GAMMA
3. END WINDOW
4. ALPHA

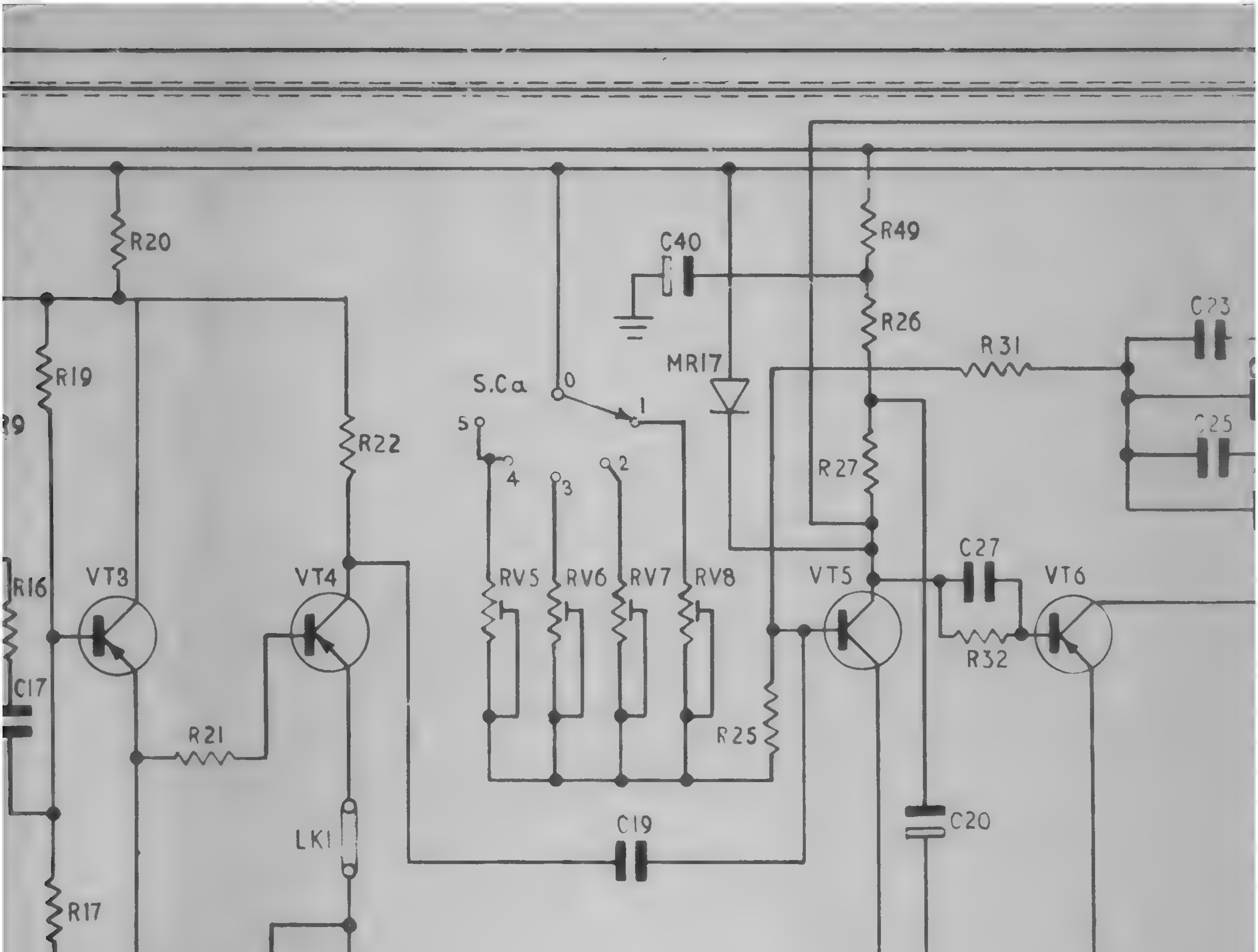
S.C. RANGE
1. X100
2. X10
3 X1
4. X0·1
5. B.G

S D

DRG. No.
6437-101



R54
MR1
MR2
MR3
MR4
MR5
MR6
MR7
MR8
MR9
R9
C7
C8
C9
C10
C11
C12
C13
C14
C15
C16
C21
C17
S.Bb
S.Bd
S.Ab
SBc
R8
R10
R11
R12
R13
R14
R15
R16
R17
R18
R19
R20
R23
VT3
SPEAKER
1. OFF
2. ON
SKT.A
ALPHA
PROBE
SKT.B
BETA GAMMA AND
END WINDOW PROBES
S.E. PROBE
1. 0
2. 1
3. 2
4. 3.
5. 4.
6. 5

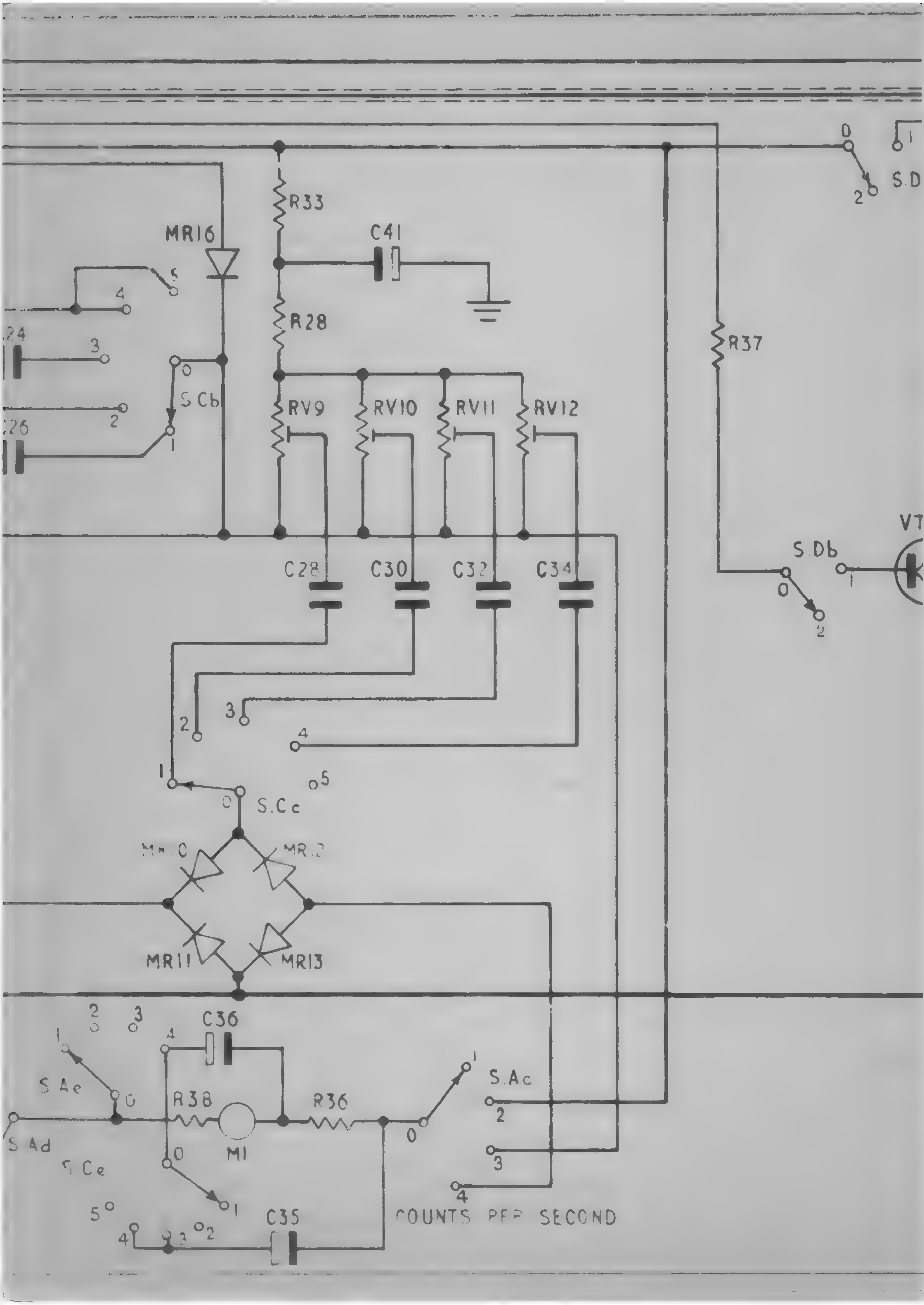


S E. PROBE VOLTAGE

1.	0	7	6
2.	1	8	7.
3.	2	9	8
4.	3.	10	9.
5.	4.	11	10.
6.	5		

S F BATTERY

1	INTERNAL
2	EXTERNAL



R33
C41
MR16
R28
R37
S.D
S.Cb
RV9
RV10
RV11
RV12
S.Db
C28
C30
C32
C34
S.Cc
MR11
MR13
C36
S.Ae
R38
R36
S.Ac
S.Ad
S.Ce
M1
C35
COUNTS PER SECOND

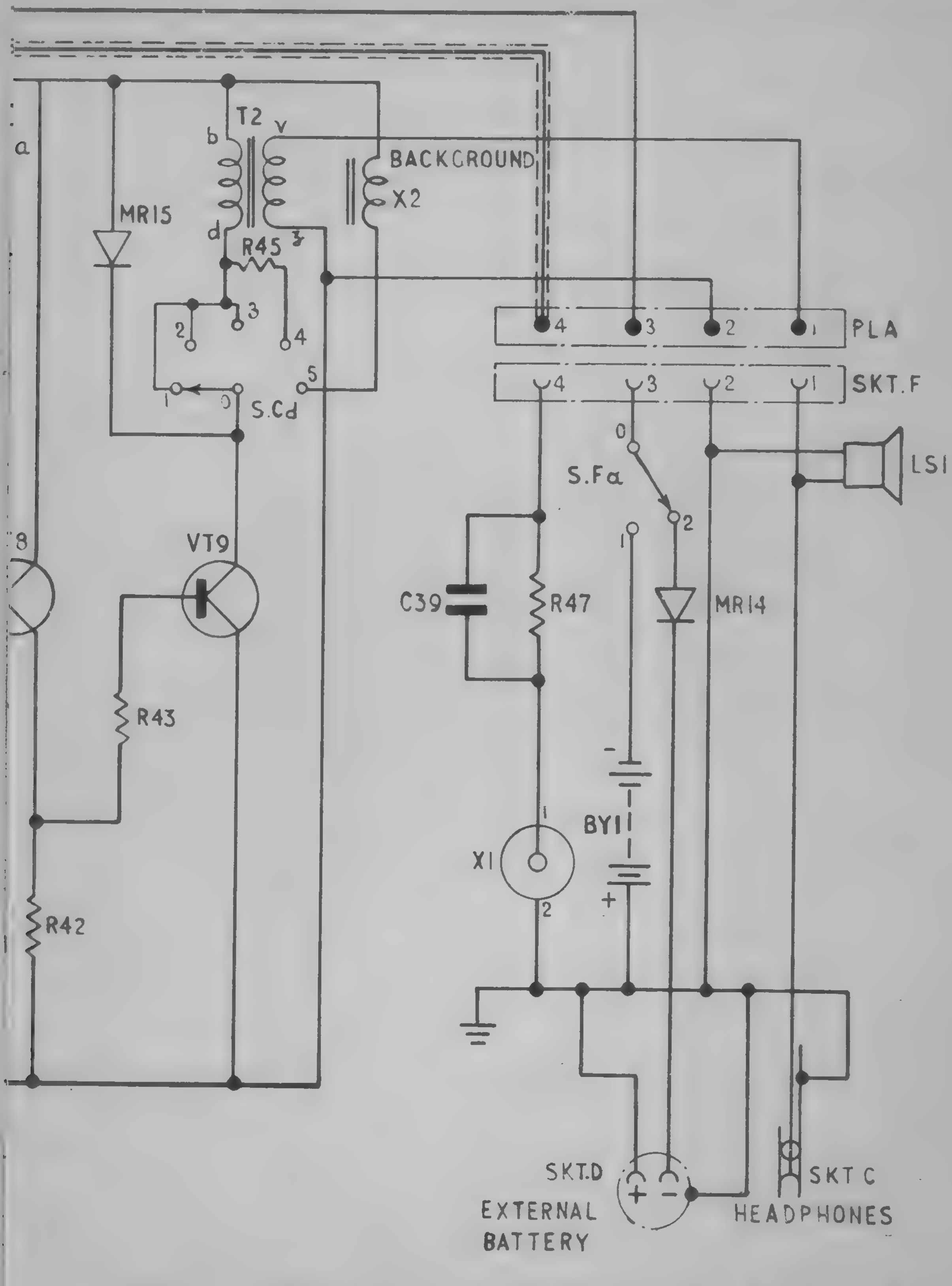


FIG.7. RADIATION MONITOR TYPE 255
CIRCUIT DIAGRAM

DRG. No.
437-101

3.11. Headphones

Headphones or a hearing-aid type earpiece can be used in very noisy surroundings; their input impedance should be in the range 15Ω - 4000Ω. Connect them to the pins marked HEADPHONE and E (earth) on the output socket.

3.12. External power supply

The monitor may be driven from an external 10 to 14V dc power supply, connected to the EXTERNAL BATTERY socket on the case. OBSERVE CORRECT POLARITY WHEN CONNECTING. Take the cover off the screwdriver-operated changeover switch on the case and set it to EXT.

3.13. Probe storage

When not in use, store the probes and sample holder in their compartments in the carrying case. If only one probe is to be used for some time it may be stored on the side of the Ratemeter Unit under the straps provided.

4. CIRCUIT DESCRIPTION

4.1. General

The complete equipment consists of a ratemeter unit, four types of probe, and a sample holder.

The ratemeter unit contains all the circuitry, indicators, power supplies, controls, and a built-in Geiger tube. Connectors are provided for driving headphones or an external scaler and for operation from external power supplies. Coaxial sockets on the control panel provide connections for the probes.

The four probes available are Alpha, Beta-Gamma, End Window, and Liquid Sample. These are connected to the ratemeter unit by a special 6-foot cable suitable for any probe, with terminations arranged so that the low voltage probes cannot be accidentally connected to the high voltage alpha probe socket.

The sample holder enables alpha, beta, and gamma measurements to be made on samples of known size and shape.

4.2. Ratemeter Unit

See Figure 7 and Table 1 for the circuit diagram and components list. Component location diagrams are given in Figures 1, 2, 5 and 6.

The unit is described in detail under the following headings:-

4.2.1. Battery supplies

The internal battery consists of eight leakproof U2-type cells arranged in series to form a 12V supply. The positive side of this supply is earthed to the case; the negative side is switched and drives the unit through a 250mA fuse.

A socket SKTD is provided on the end of the case for connecting to an external supply if required. The external supply, in the voltage range 10 to 14V, may be obtained from dry batteries, an accumulator, or a mains power unit capable of supplying the required current. To change to external supply it is only necessary to set the Battery switch to EXT. The internal battery need not be removed for this purpose, but it is best not to leave it in the instrument for long periods.

4.2.2. Meter and stabilised line

Meter M1 on the front panel is normally used to indicate the counting rate, but may be switched by means of the Internal Check switch SA to read either the battery voltage or the voltage of the internal 6V stabilised line. The meter has a fully calibrated scale of 0-50 counts per second in black and two additional points marked "6V" and "9V" in red.

The meter is heavily damped on the X1 and ÷10 counting ranges; its time constant is such that the pointer takes approximately 6.0 seconds to rise from zero to "30 counts per second" when a signal equivalent to fsd is applied.

The voltage stabiliser consists of zener diode MR18 and transistors VT1, VT7 and the associated circuits, and provides a stabilised 6V line for the probe voltage generator, the ratemeter circuit and the signal amplifier.

VT1, VT7 are operated as emitter followers in tandem, resulting in a very low impedance line from VT1 emitter. The potential of this line is held constant by zener diode MR18 and can be adjusted to exactly -6V by RV1 (the front panel control marked "Set 6V").

4.2.3. Probe voltage generator

The voltages for the various probes are obtained from a ringing-choke dc converter comprising VT2, T1, and the following voltage multiplier.

VT2 operates as a squarewave oscillator, with positive feedback from collector to base provided by T1. A high ratio secondary winding on the transformer feeds into a Cockcroft-Walton voltage multiplier consisting of three doubling stages in series. Outputs are taken from after the first, second, and third stages to give output voltages of 300, 550, and 800V. Outputs from the first and second stages are switched as required to probe socket SKB via the smoothing circuit R12, C14, and the partial probe load resistor R13. The output from the third stage is connected to the alpha probe socket SKA via the smoothing circuit R9, C12, and the load resistor R10.

A variable output voltage is obtained by adding the voltage obtained from a further doubling stage, comprising MR7/MR8 and C10/C11, in series with any of the above outputs. The "add-on" doubling stage is fed from tappings on the secondary of T1 and gives ten voltage increments of 25 to 40V each.

The exact ranges required have been set up by the internal preset potentiometer RV2 which alters the mean base current of VT2 and so alters the amplitude of oscillation of the dc converter.

The neon indicator V1 is connected in series with R51 across the full secondary winding of T1. This gives an indication that the dc converter is operating and serves as a warning that the equipment is switched on. A long life for the neon is assured by operating it from an alternating voltage source.

4.2.4. Signal amplifier

VT3, VT4 form a two-stage pulse amplifier, biased to accept negative pulses from the probes, and negative feedback is applied to the first stage to increase its input impedance.

The output from the probe in use is selected by the Select Probe switch SWB, and applied to VT3 base via a limiter circuit MR9, R15, R16, R23. The input impedance is effectively the input impedance of VT3 and is about 10kΩ.

4.2.5. Ratemeter circuit

The ratemeter circuit consists of a monostable multivibrator to provide pre-determined paralysis times, followed by an integrating circuit to give a steady indication of count rate on meter M1.

VT5, VT6 form a monostable circuit which rests with VT5 bottomed and VT6 cut off. A negative triggering pulse from the second stage amplifier VT4 is applied to VT5 base via C19, and causes VT5, VT6 to reverse their states for a period determined by the time constant of the circuit C23 - 26, R25, RV5 - 8, as selected by SCa and SCb. At the end of this period the circuit reverts to its stable state and is ready to accept another input pulse from VT4.

The length of time the circuit remains in its unstable state (the "paralysis time") is adjusted by presets RV5 - 8 to 10% of the period for a regular pulsed input corresponding to fsd for the range selected by SC. The following paralysis times are provided:-

Range	Paralysis Time
x 100	20µS
x 10	200µS
x 1	2mS
÷ 10	20mS
BG	20mS

An output for driving an external scaler is taken from the junction of R26/ R27 in the collector load of VT5, via dc isolating capacitor C20, to SKTC on the outside of the case. The waveform is a negative-going rectangular pulse with a width approximately equal to the paralysis time and an amplitude of more than 1V.

VT6 collector voltage changes from 6V when cut off (clamped by MR16) to approximately 0.1V when fully conducting and bottomed. This voltage change is used to fully charge and discharge C28, C30, C32, C34; the current into and out of the selected capacitor drives meter M1 through SCc and full-wave bridge rectifier MR10 - 13. Full scale deflection is set up on each range by the series presets RV9 - 12, which determine the amplitude of the charging pulses fed to the associated capacitors.

The meter circuit is damped to average out the variations of input frequency caused by the random nature of nuclear radiation. This is done partly by a heavily damped meter movement and partly by C35, C36: the order of damping is such that the meter needle takes at least 0.6 seconds to reach 60% fsd on the x100 and x10 ranges when an input corresponding to fsd is applied; on the x1 and ÷ 10 ranges it takes 6 seconds.

4.2.6. Audio amplifier

In the "Normal" (4) position of SA, the negative pulse appearing at VT5 collector is amplified by VT8, VT9 and drives either the loudspeaker LS1 or the

electromagnetic register X2, as selected by SCd. The first amplifier stage VT8 is arranged as an emitter follower and is biased to cut-off for minimum battery drain; the second stage, grounded-emitter VT9, is also biased to collector current cut-off and is driven into the bottoming condition for maximum efficiency.

The pulse waveform is preserved in passing through the amplifier, so that a sharp click is produced in the speaker each time the monostable VT5, VT6 operates. The speaker can be used up to the maximum counting rate of the equipment (5000 counts/second), but the maximum counting rate of the register is limited by the register itself to 25 counts/second. In using the register to count the input, the resolution time is more significant than its maximum count rate; resolution time is 20mS, equal to the paralysis time of the monostable circuit VT5, VT6 on the ÷ 10 range.

Selecting the "Speaker Off" (5) position of SA takes the amplifier out of circuit and breaks the 12V supply to it.

4.2.7. Internal geiger

A geiger tube X1 (Type G10H) is mounted inside the case of the Ratemeter Unit for detecting and monitoring gamma radiation. The tube is mounted in the battery compartment between the two rows of batteries in a shock absorbing mounting. The attenuation of gamma radiation by the batteries and lower lid is negligible, the radiation sensitivity being of the order of 0.1 MeV.

The tube is connected to the input socket SKTB when the Select Probe switch SB is set to Internal. A load resistance of 10.5MΩ is provided by R47, R13 to give a plateau length of at least 100V. The steep leading edge of the pulse from the geiger is preserved by C39 in parallel with the 10MΩ resistor R47. The large negative pulse developed at the anode of the geiger tube is attenuated by this split load resistance to an amplitude acceptable by the signal amplifier VT3, VT4.

4.3. Probes

Circuit diagrams of the probes are given in Figures 3 and 4.

4.3.1. Beta-Gamma probe

This is in the form of a cylindrical container incorporating a low-voltage thin-walled geiger tube Type B12H for beta and gamma measurements. The wall density of the tube is 30 - 35mg/cm^2, the sensitivity is 0.5 MeV beta and the dead time is of the order of 300μS.

The sensitivity to gamma radiation is approximately 14,500 counts per minute for a radiation field of 2.5 millirad/hr from a Cobalt-60 source.

The total load resistance is 10.5MΩ, of which 10MΩ is within the probe to minimise the effect of stray capacitance on the pulse shape. The steep leading edge of the output pulse is preserved by a 3.3pF capacitor in parallel with the 10MΩ resistor and the resulting plateau length is at least 100V.

A shutter on the side of the probe can be closed to stop beta particles and allow it to be used for monitoring gamma radiation only. The geiger tube is coated with colloidal graphite to exclude light when the probe is operated with the shutter open. The outer casing may be completely removed to allow the geiger tube to be immersed in liquids.

The probe handle can be fitted in either of two ways; one of these positions enables the probe to be attached to a pole when the user wishes to remain at a distance from the source of radio-activity.

4.3.2. Alpha probe

This is a scintillation type of probe for detecting alpha particles. It employs a zinc sulphide scintillation screen, the light from which is concentrated by a prismoid light guide on to a photomultiplier tube Type 27M1. The light excluding screen in front of the phosphor is an aluminised terylene film with a density of 1mg/cm^2.

The effective screen area of the Probe is 5 in^2 and the sensitivity is such that it will detect alpha particles with an energy of 4 MeV or greater.

Although the terylene film covering the probe window is extremely tough and will stand up to all normal usage, a sliding metal cover is provided to protect it when the Probe is not in use.

The handle is identical with that used on the Beta-Gamma Probe and can be fitted in either of two ways.

4.3.3. End Window probe

This is suitable for detecting high energy alpha and low energy beta radiation. It employs an end-window geiger tube Type EW3H, with a window density of 1.5 to 2.5mg/cm^2 and a sensitivity of 0.1 MeV beta. The dead time of the tube is of the order of 700μS.

A window of aluminised terylene film with a density of 1mg/cm^2 is fitted to keep light out. This may be removed to obtain the full tube sensitivity when the probe is used with the sample holder, or if light can be kept out in some other way.

The total load resistance is 10.5MΩ, of which 10MΩ is mounted within the probe, shunted by a 15pF capacitor to preserve the pulse shape. The length of the plateau is at least 100V.

The handle, which is identical with that used on the Beta-Gamma probe, can be mounted in either of two positions.

4.3.4. Liquid Sample probe

This consists of a special geiger tube Type M2H, designed to hold 5 millilitres of liquid with a fixed source geometry, mounted on a rigid base casting. The tube itself is sheathed in rubber and has a rubber top cap attached by a light chain.

The wall density of the tube is $15 mg/cm^2$, sensitivity is 0.5 MeV beta, and dead time is of the order of 150μS.

The load resistance is 10.5MΩ, of which 10MΩ is within the probe, shunted by a 15pF capacitor. The plateau length is greater than 100V.

5. SERVICING

5.1. General

Battery and fuse replacements are the only changes normally needed. The batteries are accessible by removing the lower lid, as shown in Figure 2. Observe correct polarity. The fuse is removable from the end of the unit.

WARNING - DO NOT LEAVE BATTERIES IN UNIT FOR LONG PERIODS.

If any further servicing is undertaken it is necessary to remove the front panel assembly from the remainder of the unit. This can be done by unscrewing the six captive screws on the front panel, carefully withdrawing the front panel assembly, and disconnecting the internal plug and socket. The positions of components, including those on the printed circuit boards, are shown on Figures 1, 5 and 6. Typical circuit voltages are given in Table 2.

Details of further setting up procedures are given below. The circuit diagram of the Ratemeter Unit is shown in Figure 7 and those of the Probes are in Figures 3 and 4.

5.2. 6V line

Functioning of zener diode MR18 and transistors VT1 and VT7 can be tested as follows:-

> Check for correct battery voltage, then set the Internal Check switch to "6V LINE".
>
> Set the Range switch to "x10" or "x100".
>
> The meter should read exactly to the red "6V" mark on the scale. If it does not, try adjusting the "Set 6V" potentiometer RV1. If RV1 shows a marked lack of control, suspect a fault in one of the above components.

Replacing the faulty component will restore full control to RV1 and enable a reading of 6V to be obtained on the meter.

5.3. Probe Voltage Ranges

Replacing transistor VT2 or an associated component may necessitate re-setting the voltage ranges provided by the dc converter.

Adjust RV2 to give the voltage ranges stated in the Specification, Section 6.

5.4. Dead time

Replacing components associated with transistors VT5 and VT6 may alter the dead time of the trigger circuit.

Reset the circuit on each range by injecting pairs of pulses spaced by the required dead time, and adjust the appropriate internal preset potentiometer until the circuit just fails to count all pulses. Adjust RV5, RV6, RV7, and RV8 for the ÷ 10, x1, x10, and x100 ranges respectively, and lock them with paint.

5.5. Accuracy

After adjusting the dead time, or after replacing a component in the meter circuit, the instrument may be less accurate than specified in Section 6.

Accuracy can be restored by providing a regular negative pulse input with a pulse repetition frequency corresponding to full scale meter calibration and adjusting the appropriate internal preset potentiometer to give full scale deflection on the meter. Adjust RV9, RV10, RV11, and RV12 for the X100, X10, X1, and ÷ 10 ranges respectively and lock them with paint.

5.6. Beta Gamma Probe

If it is necessary to replace the geiger tube type B12H, remove the three 4BA screws nearest to the connector and carefully withdraw the internal assembly. Remove the geiger tube from the valveholder and plug the new one in. To exclude light, apply a coat of "Dag" dispersion 580 colloidal graphite in alcohol to the whole of the glass envelope and allow it to dry. When dry, carefully insert the internal assembly into the probe and replace the 4BA screws.

5.7. End Window Probe

To replace the geiger tube type EW3H, remove the rubber sleeve and the three 4BA screws and take out the internal assembly. Remove the geiger tube from the valveholder and plug the new one in. Ensure that the terylene film light screen and PVC ring are in place in the probe with the ring uppermost, then carefully replace the internal assembly. Gently push the geiger tube up to the wire mesh, tighten the 4BA screws, and replace the rubber sleeve.

5.8. Alpha Probe

To replace the photomultiplier tube, unscrew the two 4BA screws at the connector end of the probe and remove the outer cover. Carefully remove the valveholder assembly from the base of the photomultiplier, taking care not to break the two flexible leads. Place the first two fingers of both hands on the rubber moulding just below the base of the photomultiplier and both thumbs at the other end of the moulding at the top. Press with both thumbs until the base of the photomultiplier emerges. Take care not to distort the lower half of the moulding, for this may damage the coating of phosphor on the prismoid light guide and cause a loss of efficiency. Grip the base and remove the photomultiplier tube. Take the new photomultiplier tube, lightly smear the base with Hellerine Oil or Silicone Grease and insert into the rubber moulding with the spigot downwards. Wipe away any surplus grease, replace the valveholder assembly and the outer cover.

Replacing the photomultiplier tube by one with a higher than usual sensitivity may result in a high noise level even with the probe voltage set at minimum. If this is the case, connect a fixed 10MΩ 10% 1/2 Watt resistor to replace the lead between pin 11 on the valveholder and the earth tag on the concentric socket, in order to reduce the probe voltage by 100V.

If the probe already has a resistor fitted when the photomultiplier tube is changed it should not be removed, unless the operating point is outside the range of the Probe Voltage switch.

6. PERFORMANCE SPECIFICATION

Indication

A 2.1/2" meter on the front panel gives an indication of radiation intensity in counts per second.

A four-figure electromagnetic counter on the front panel is used for background counting.

Audible indication is provided by a built-in 3" loudspeaker. This facility is available on all ranges except the Background range and may be switched off when not required.

Headphones or a hearing-aid type earphone may be connected to a socket on the case.

Counting Ranges

The main control selects one of the following meter ranges:-

0 -	5,000	counts/second		(x 100 range)
0 -	500	"	"	(x 10 range)
0 -	50	"	"	(x 1 range)
0 -	5	"	"	(÷ 10 range)

Background Range

A fifth position on the main control selects the electromagnetic register for background counting. The maximum counting rate for regular pulses is 25/second, and for random inputs the resolution time is 20mS. When not in use the register is out of circuit to avoid a drain on the batteries.

Accuracy	The accuracy of measurement for a regular pulse input is better than ±2.5% of fsd on the x 100, x 10, and x1 ranges, and better than ±3% of fsd on the ÷ 10 range.
Dead Time	The circuit dead times on the counting ranges are:- x100 range 20 µS x 10 " 200 µS x 1 " 2 mS ÷ 10 " 20 mS
Stability	A preset control on the front panel marked "SET 6V" enables compensation to be obtained for a fall in battery voltage from 12 to 9V. The electro-mechanical register is unaffected by a fall of battery voltage of 25% (12 to 9V).
Temperature Range	The equipment operates satisfactorily over the temperature range 0 to 40°C, the accuracies quoted being those at 20°C and below. At 40°C no error is increased by more than a factor of 2.
Output	A negative pulse of not less than 1V amplitude and of constant level is available at a socket on the case for driving an external scaler.
Internal Geiger Tube	A robust low-voltage geiger tube for gamma radiation is mounted inside the Ratemeter Unit and can be selected by a panel switch. It will detect gamma radiation down to 0.1 MeV.
Probe Voltages	The voltage ranges available for the probes are approximately 300 - 550V, 550 - 800V, and 800 - 1200V. Each range is variable in steps of about 30V. The voltages are stabilised and do not fall by more than 1.5% for a fall in battery voltage of 25% (12 to 9V).

PROBES

	Alpha Probe	End Window Probe	Liquid Sample Probe	Beta-Gamma Probe		Internal Ratemeter Sensor
Type	27M1 Photo multiplier	EW3H Geiger	M2H Geiger	B12H Geiger		G10H Geiger
Temperature Range	$-10^{\circ}C$ to $+50^{\circ}C$					$0^{\circ}C$ to $40^{\circ}C$ limited by ratemeter
Radiation Sensed	Alpha only	Beta	Beta	Shutter Open Beta	Shutter Closed Gamma only	Gamma only
Lower Energy Limit	4 MeV	0.1Mev (C14)	0.5Mev	0.5Mev	0.1Mev	0.1Mev
Minimum Detectable Level	3×10^{-5} $\mu C/cm^2$	3×10^{-2} $\mu C/cm^2$	3×10^{-4} $\mu C/ml$ at 0.5Mev 3×10^{-5} $\mu C/ml$ at 3MeV	5×10^{-4} $\mu C/cm^2$	15×10^{-3} mR/hr	
Counting Efficiency	10% with Pu - 239	7000/min. for 2.5 mR/hr with Co - 60	0.5% at 0.5MeV 7% at 3MeV	20% at 0.5MeV 80% at 3MeV	15,000/min for 2.5mR/hr with Co - 60	
Wall Density	$1 mg/cm^2$	$2 mg/cm^2$ window off. $3 mg/cm^2$ window on	$15 mg/cm^2$	$30 mg/cm^2$	$1000 mg/cm^2$	
Maximum Usable Level	5000/sec at least.	500/sec.	5×10^{-1} $\mu C/ml$ at 0.5MeV 5×10^{-2} $\mu C/ml$ at 3MeV	30mR/hr		

PROBES

	Alpha Probe	End Window Probe	Liquid Sample Probe	Beta-Gamma Probe	Internal Ratemeter Sensor
Unshielded Background Rate	5/min	40/min	20/min	100/min	
Dead Time	10µS	700µS	150µS	300µS	
Effective Geometry	Window size 5cm x 6cm	Window size 2.5cm dia.	Liquid capacity 5ml	Sensitive length of Geiger 12cm	

Connector

A 6ft connector is supplied, suitable for use with any of the probes. The terminations are arranged so that none of the low voltage probes can accidentally be plugged into the high voltage Alpha Probe socket on the front panel.

Sample Holder

This is designed for use with either the End Window Probe or the Alpha Probe to give a fixed source geometry. The drawer will take a 1.3/4" diameter x 1/4" deep dish or standard A.E.R.E. 2" square sample tray.

Weight

Ratemeter Unit	16 lb	(including batteries)	7.2kg
Beta Gamma Probe	14 oz	(less handle)	0.4kg
End-Window Probe	7 oz	" "	0.2kg
Alpha Probe	1 lb 1 oz	" "	0.5kg
Liquid Sample Probe	12 oz		0.35kg
Sample Holder	1 lb 7 oz		0.65kg
Handle	3.5 oz		0.1kg
Connector	3.5 oz		0.1kg
Total Weight	21 lb 0 oz		9.5kg

TABLE 2

RADIATION MONITOR TYPE 255

COMPONENTS LIST

Circuit Reference	Details			Type
	Resistance Ω	Tolerance ±%	Rating W	
Resistors				
R1	470	5	1/4	Erie 109
R2	10 k	10	1/4	Erie 16
R3	3.3k	5	1/4	Erie 109
R4	3.9k	5	1/4	Erie 109
R5	330	5	1/4	Erie 109
R6	15	10	1/4	Erie RMA9
R7	220	5	1/4	Erie 109
R8	100 k	10	1/4	Erie RMA9
R9	1 M	10	1/4	Erie RMA9
R10	1.5M	5	1/2	Erie 108
R11	1. M	10	1/4	Erie RMA9
R12 - R14	470 k	10	1/4	Erie RMA9
R15,16.	10 k	5	1/4	Erie 109
R17	100 k	5	1/4	Erie 109
R18	4.7k	5	1/4	Erie 109
R19	680 k	5	1/2	Erie 108
R20	270	5	1/4	Erie 109
R21	470	5	1/4	Erie 109
R22	1 k	5	1/4	Erie 109
R23	100 k	5	1/4	Erie 109
R24	680	5	1/4	Erie 109
R25	10 k	5	1/4	Erie 109
R26	470	5	1/4	Erie 109
R27,28.	1 k	5	1/4	Erie 109
R29	150 k	5	1/4	Erie 109
R30	1 k	5	1/4	Erie 109
R31	470	5	1/4	Erie 109
R32	22 k	5	1/4	Erie 109
R33	1 k	5	1/4	Erie 109
R34	270 k	5	1/4	Erie 109
R35	27 k	5	1/4	Erie 109

TABLE 2
(Continued)

RADIATION MONITOR TYPE 255

COMPONENTS LIST

Circuit Reference	Details			Type
	Resistance Ω	Tolerance ±%	Rating W	
Resistors				
R36	2.7k	5	1/4	Erie 109
R37	2.2k	5	1/4	Erie 109
R38	2.2k	5	1/4	Erie 109
R39,40.	Not used			
R41	10 k	10	1/4	Erie 16
R42	2.7k	5	1/4	Erie 109
R43	680	5	1/4	Erie 109
R44	22 M	5	1/2	Erie 108
R45	Not used			
R46	22 M	5	1/2	Erie 108
R47	10 M	10	1/2	Erie RMA8
R48	10 k	10	1/4	Erie 16
R49	470	5	1/4	Erie 109
R50	10 k	10	1/4	Erie 16
R51	2.2M	10	1/2	Erie RMA8
R52 - R54	22 M	5	1/2	Erie 108
Variable Resistors				
RV1	1 k car.lin.	20	1/4	Morgan LH
RV2	2.2k w.w.lin.	10	1	Colvern CLR/1106/11S
RV3,4.	Not used			
RV5 - RV8	10 k car.lin.	20	1/4	Plessey MP Dealer BLACK
RV9 - RV12	1 k car.lin.	20	1/4	Plessey MP Dealer BLACK
	Capacitance F	Tolerance ±%	Rating V	
Capacitors				
C1	1000 μ	-20+50	12	Plessey CE1236/1
C2,3.	Not used			

TABLE 2
(Continued)

RADIATION MONITOR TYPE 255

COMPONENTS LIST

Circuit Reference	Details			Type
	Capacitance F	Tolerance ±%	Rating V	
Capacitors				
C4 - C11	0.1μ	20	350	TCC Metalmite
C12	0.1μ	20	1500	Hunts L45B426
C13	0.01μ	10	2000	GEC Polystyrene PF
C14	0.05μ	20	1000	Hunts L45B415
C15	0.01μ	10	2000	GEC Polystyrene PF
C16	100 μ	-20+100	6	Plessey CE1207
C17	0.1 μ	20	150	Hunts W.48
C18	100 μ	-20+100	3	Plessey CE1210
C19	0.002μ	20	400	Hunts W99/B818
C20	100 μ	-20+100	6	Plessey CE1207
C21	0.1μ	20	150	Hunts W.48
C22	Not used			
C23	1.5μ	5	150	GEC Polyester PFT
C24	0.15μ	5	150	GEC Polyester PFT
C25	15000 p	5	125	GEC Polystyrene PF
C26	1500 p	5	125	GEC Polystyrene PF
C27	100 p	20	350	TCC Mica SMWN
C28	1200 p	5	125	GEC Polystyrene PF
C29	Not used			
C30	11,200 p	5	125	GEC Polystyrene PF
C31	Not used			
C32	112,000 p	5	125	GEC Polystyrene PF
C33	Not used			
C34	1.11μ	5	125	GEC Polystyrene PF
C35	100 μ	-20+100	1.5	Plessey CE1208 (with tags)
C36	1000 μ	-20+100	1.5	Plessey CE1242 (with tags)
C37	Not used			
C38	8 μ	-20+10	15	Plessey CE1272/1
C39	3.3p	±1/2pF	750	Erie P100/AD
C40,41.	200 μ	-20+100	12	Plessey CE1234

TABLE 2
(Continued)
RADIATION MONITOR TYPE 255
COMPONENTS LIST

Circuit Reference	Details	Type
Transistors		
VT1	Germanium PNP	Mullard OC.83
VT2	" "	Mullard OC.83
VT3 - VT6	" "	Mullard OC.42
VT7	" "	Mullard OC.71
VT8,9.	" "	Mullard OC.83
Rectifiers		
MR1 - MR8	Selenium	Westinghouse 39K7
MR9	Gold bonded germanium	Mullard OA.5
MR10 - MR13	Selenium	Westinghouse W1
MR14	Gold bonded germanium	Mullard OA.5
MR15	Germanium	Mullard OA.91
MR16,17.	Gold bonded germanium	Mullard OA.5
MR18	Silicon zener	Mullard OAZ.204
Switches		
SA	Rotary 8 pole 5 position DH	NSF 6437-280
SB	Rotary 4 pole 4 position DH	NSF 6437-281
SC	Rotary 5 pole 5 position DH	NSF 6437-282
SD	Not used	
SE	Rotary 1 pole 11 position DH	NSF 6437-283
SF	Rotary 1 pole 2 position DH	NSF 6437-279

TABLE 2
(Continued)

RADIATION MONITOR TYPE 255

COMPONENTS LIST

Circuit Reference	Details	Type
Plugs and Sockets		
PLA	Plug 6 way	McMurdo PP.6
SKTA	Socket Concentric	PET 141/LA
SKTB	Socket Concentric	Films & Equip. JS1-PF
SKTC	Socket 3 way	Belling Lee L790/CS
SKTD	Socket 2 way	Belling Lee L789/CS
SKTE	Not used	
SKTF	Socket 6 way	McMurdo PS.6
Miscellaneous		
BY1	Battery 8 off Leak Proof U2 size	Ever Ready 1·5V D-cells
FS1	Fuse miniature cartridge 250mA	Belling Lee L562
LS1	Loudspeaker 35Ω 3" dia.	Elac 35L/67
M1	Meter 50μA fsd 950Ω 2 sec. response	Sifam Wessex Type M31 To 6437-172
T1	Transformer	Airmec 6437-153
X1	Geiger Tube (Gamma only)	20th Century Electronics G10H
X2	E - M Counter 100Ω 9V	Counting Instruments (with Nylon pinion) 54/4A/A32
Associated Equipment		
Connector Assembly (6437-401)		
	Plug free concentric	PET 101/LA/UR70/DEM
	Plug free concentric	Films & Equipment JP1-250-CCT
	Cable 6 feet	BICC T3283

TABLE 2
(Concluded)

RADIATION MONITOR TYPE 255

COMPONENTS LIST

Circuit Reference	Details	Type
Beta-Gamma Probe (6438-100)		
R1	Carbon Resistor 10MΩ ±10% 1/2W	Erie RMA8
C1	Ceramic Capacitor 3.3pF ±1/2pF 750V	Erie P100/AD
X1	Geiger Tube 750V B12H	20th Century Electronics
SKTA	Socket fixed concentric	PET 141/LA
Liquid Sample Probe (6439-100)		
R1	Carbon Resistor 10MΩ ±10% 1/2W	Erie RMA8
C1	Ceramic Capacitor 15pF ±10% 750V	Erie P100/BD
X1	Geiger Tube M2H	20th Century Electronics
SKTA	Socket fixed concentric	PET 142/LA
End Window Probe (6440-100)		
R1	Carbon Resistor 10MΩ ±10% 1/2W	Erie RMA8
C1	Ceramic Capacitor 15pF ±10% 750V	Erie P100/BD
X1	Geiger Tube EW3H	20th Century Electronics
SKTA	Socket fixed concentric	PET 141/LA
Alpha Probe (6441-100)		
R1 - R10	Carbon Resistor 10MΩ ±5% 1/2W	Erie 108
C1,2.	Ceramic Capacitor 50pF ±20% 4kV	TCC HVD3
X1	Photomultiplier 27M1	Mazda
SKTA	Socket fixed concentric	Films & Equipment JS1-PF
Probe Case		Airmec 6437-410
Sample Holder		Airmec 6458-100
Lead Castle Type 295		Airmec

TABLE 3

RADIATION MONITOR TYPE 255

TYPICAL CIRCUIT VOLTAGES

The following dc circuit voltages should be obtained using an Avometer Model 8. Set the unit to "Normal" and "BG".

Reference	Measure between earth and the following points	Typical Voltage (Volts)	Meter Range
1	C1 negative	-5.8	10V
2	VT2 collector	-5.6	10V
3	VT2 base	+0.5	2.5V
4	VT3 collector	-5.4	10V
5	VT3 base	-0.3	2.5V
6	VT3 emitter	-0.5	2.5V
7	VT4 collector	-5.4	10V
8	VT4 base	-0.5	2.5V
9	VT4 emitter	-0.4	2.5V
10	VT5 collector	-0.05	2.5V
11	VT5 base	-0.2	2.5V
12	VT6 collector	-6.1	10V
13	VT6 base	-0.05	2.5V
14	VT8 collector	-12.0	25V
15	VT8 base	-0.1	2.5V
16	VT8 emitter	-0.1	2.5V
17	VT9 collector	-12.0	25V
18	VT9 base	-0.05	2.5V